

## INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

December 9, 1958

To: C. J. Borkowski  
 E. P. Epler  
 I. H. Jordan  
 M. E. Ramsey  
 C. E. Winters  
 E. O. Wollan  
 H. P. Yockey

This document has been approved for release  
 to the public by:

*David R. Hamlin* 11/16/95  
 Technical Information Officer Date  
 ORNL Site

Subject: Information for Review of LITR Operation

Operation of the LITR during 1958 has been relatively trouble free. The only significant operational difficulty has been in connection with shim rod magnet failures. The modification of existing magnets or the fabrication of magnets of a new design is under consideration. Magnet failures have been the greatest source of component-failure shutdowns (approximately 50%) during the year.

No trouble has been experienced with the remote control facility.

### Shutdowns

The number of shutdowns caused by reactor control component failures is impressive. Twenty reactor component-failure shutdowns have been experienced to date during 1958. Component-failure shutdowns during the three preceding years were as follows: 28 during 1957, 50 during 1956, and 63 during 1955. A constantly improving instrument maintenance program is mainly responsible for the decreasing number of unscheduled reactor shutdowns. An analysis of unscheduled shutdowns through the third calendar quarter follows.

### Shutdown Analysis

	<u>Number</u>	<u>Total Downtime (hr)</u>
Human Error		
Operations	1	0.383
Research	12	5.766
Instrument Department	1	0.717
Subtotal	14	6.866
Equipment Failures		
Operations	17	49.501
Research	75	248.970
Subtotal	92	298.471
TOTAL	106	305.337

### Instrument Changes

The two mercury manometers, one indicating coolant flow and the other indicating seal tank water level, have been replaced with oil manometers.

### Facility Changes

The demand for experimental facilities at the LLTR has been greater than at any time in its history. With the advent of the Gas Cooled Reactor Project, the demand became so pressing that four additional vertical access holes were established. These facilities, in core positions C-47, C-57, C-58, and C-39, increased the number of vertical tubes from seven to eleven. Heretofore, seven was thought to be about the maximum number of facilities of this type. The nuclear considerations were reviewed by the Operations Division Technical Group and were found to be acceptable.

It is noteworthy that the Naval Research Laboratory was permitted to use HB-3 periodically during 1953. NRL is requesting permanent assignment of a beam hole facility.

Attached is a diagram of the lattice showing research facilities in relation to fuel and reflector pieces (Figure 1a). The lattice arrangement at the beginning of the year is contrasted to the lattice arrangement now.

### Items Dropped Into Tank

Two items were dropped into the reactor vessel--a mechanical pencil by "C" shift on February 4 and a standard sulfur irradiation unit by "B" shift on May 27. The location of the pencil was not determined. The sulfur unit fell into the east section of "D" tank, between the beam holes.

### Radiation Incidents

There were two incidents during 1953 that involved the release of sufficient radioactivity from experimental facilities to require evacuation of the west room of the LLTR. The source of the trouble is dry bronze bearings in the high flux zone of each of the three HB-5 facilities. Since the HB-5 experiments are of the rocking autoclave type, wear on the bearings results in highly radioactive bearing dust that adheres to the plugs of experiments.

The first incident began at approximately 10:30 a.m. on November 13, 1951, when an attempt was made to vacuum clean two of the three facilities of HB-5. The purpose of the cleaning was to partially eliminate the spread of contamination accompanying removal of experiments from the three facilities.

The vacuum system consisted of a long Al tube (~15 feet in length) with "T" handles. The tube is connected to a flexible hose. A trap (vacuum cleaner bag) was installed in the flexible hose before going into the building off-gas system. A lead shield was built around the metal trap container.

The dummy plug was removed from facility No. 2 and the vacuum cleaner tube inserted. Personnel were exposed to a radiation field of 400 mr/hr as turns were taken giving each person ~10 seconds exposure in this radiation field. The tube was then removed and the "hot" end put in a plastic bag. An experiment was placed in the hole to cut off the beam. Dose rates of the vacuum system were: 5 r/hr at the "hot" end of the tube, 1 r/hr on the other end, the flexible hose read up to 2 r/hr and the trap gave a dose rate of 5 r/hr at the unshielded top.

The dummy plug from No. 3 facility was removed and the vacuum tube inserted. During cleaning of the facility, personnel were exposed to a radiation field of 1 r/hr. The same system of rotating personnel was used. A burst of activity came out of the hole raising the background in the work area to 2 r/hr. The room was evacuated. A survey of the vacuum system gave dose rates of 10 r/hr at 4" from the flexible hose in front of the trap and 10 r/hr at 2 feet from the trap. The tube was pulled from the facility and put in a plastic bag. The hot end of the tube read 10 r/hr at 4". The tube, flexible hose, and trap were then disconnected, readying them for the hot truck. During the dismantling, some of the activity escaped and grossly contaminated the floor with spots on the floor reading up to 4 r/hr and on blotter paper covering the floor up to 10 r/hr at 4". The paper was placed in hot cans and also put on the hot truck. Dose rate in the truck cab was 100 mr/hr.

The hot spots were then cleaned to reduce background in the room to 10 mr/hr, excepting the open beam. After putting the experiment in the facility, a more thorough decontamination was done.

During the operation, there was no significant amount of air activity until the vacuum system was dismantled, during which time highly radioactive copper particles were permitted to escape from an open hose joint. The CAM filter read 6 mr/hr. Personnel dismantling wore assault masks. Air activity continued until the floor had a complete cleaning. Internal exposure to personnel is unlikely since masks were worn in the room during the time of air activity. Smears of equipment in the room gave an average of 900 c/m beta-gamma. The concrete pad south of the west room was contaminated to a lesser extent and was cleaned before west room decontamination. The hose behind the trap read 12 mr/hr. Analysis of the air samples by P. E. Brown indicated activity to be Cu-64 with traces of other radioisotopes.

The second incident occurred on Tuesday, November 25, 1958, during a routine removal of a rocking capsule experiment from HB-5 of the LEET. This was not one of the holes cleaned on November 18, 1958. A wet sponge was tied around the experiment to clean off Cu-64 as the experiment came out. An off-gas hood was placed over the area immediately above the point of withdrawal from the reactor. Blotter paper was placed on the floor under the hole and adjacent equipment. A plastic bag was provided for the sponge to fall into as the experiment went into the carrier. An additional carrier was placed nearby for the sponge, if needed.

After pulling the experiment, the sponge, contained in the plastic bag, was placed in the carrier by the use of tongs. The dose rate from it was

10 r/hr at 2 feet. The carrier was then rolled to the south pad for storage. The floor along the path from the hole to the pad was found to be contaminated up to 1 r/hr. The carrier front was found contaminated and wet rags used to clean up the carrier read 10 r/hr. The pad and room were then vacuumed. This reduced the contamination to ~1 to 20 mr/hr. HB-6 was then pulled and further clean up ensued. During the removal of the experiment and insertion of a dummy plug in HB-5, the CAM in the west room showed an increase in activity with a maximum level of 7,000 c/m. Smears taken on contaminated equipment in the room gave an average counting rate of 200 c/m beta-gamma. No personnel contamination was involved.

During a more recent experiment removal, on December 2, additional precautionary measures and an improved procedure were employed and all particulate and gaseous activity was confined. The precautionary measures were: (1) the use of wet sponges to wipe the plug and experiment, (2) more extensive use of plastic bags for enclosing contamination bearing surfaces, (3) the liberal use of paper for covering the floor in the vicinity of the beam holes, and (4) the placing of wet cheese cloth under the plug removal path.

No incident has occurred in the insertion or removal of specimens from the LITR vertical facilities. A requirement has been enforced that calls for the presence of someone from the Operations supervisory group and a representative of the Health Physics group. In past years these facilities and the necessarily awkward means of removing samples have occasionally been a source of exposure problems.

### Control System

Safety innovations incorporated into the control system during 1958 are as follows:

1. A shim rod withdrawal inhibit while the fission chamber is in motion was installed.
2. The effectiveness of the block-out switch on the cooling water flow interlock was restricted to power levels below  $M_L$ . This block-out facilitates routine control system check-outs when the reactor is down.
3. In connection with the experimenters' safety tie-in circuit, the setback and scram channels were double tracked to give increased reliability. Each setback or scram signal is now channeled through two independent circuits and independent setback or scram relays, one of which drops out to effect action and the other makes up to effect action. Also, the installation of safety circuit components that will make the LITR experimenters' safety circuit like that planned for the ORR is under way.

A routine has been established to regularly check the drop time of the shim rods. Binding of the shim rods by adjacent lattice pieces would be reflected in this check.

As requested by the safety committee at the 1957 meeting, access to the area

directly above the vertical facilities was restricted by installing an expanded metal, locked fence. One of these facilities emits a neutron beam known to be considerably above tolerance for both fast and thermal neutrons when in an unplugged condition. A four foot lucite plug in this particular tube reduces neutron activity to a level below tolerance.

#### Tests on LTR Control Rods

In the 1957 meeting, questions were raised as to the worth of the control rods in their last few inches of travel and the time required for the rods to become effective.

Several tests have been performed and the results are reported here. The relative worth of the No. 2 and No. 3 rods did not check when compared by two different methods. However, this can probably be explained qualitatively by the different amounts of xenon growth in the two rods and surrounding region following a shutdown.

Three types of experiments have been performed to determine the reactivity worth of the LTR control rods as a function of drop time.

1. The rods were dropped from various heights and the time from release until the seat switches were activated was observed. The results of these tests are given in Table 1 and are plotted in Figure 1. In Figure 2, the value of the square of the flight time is plotted against the distance fallen, and the accelerations, apparently constant for drop times longer than about 300 milliseconds, are obtained from the slopes. The solid curves show the theoretical curves obtained by assuming no friction and considering that the only retarding force is due to the buoyancy of the water. The results indicate that for No. 1 and No. 3 rods the acceleration is  $15.4 \text{ ft/sec}^2$ , and for No. 2 rod the acceleration is  $20.2 \text{ ft/sec}^2$ .

It should be pointed out that because of the way in which the experiment was performed the decelerations in the shock absorbers appear as reduced accelerations during the first few inches of fall so that the initial portions of the curves probably show lower accelerations than actually occur.

2. The rods were calibrated against the growth of xenon<sup>135</sup> following a reduction of reactor power from 3 Mw to virtually zero power. Figure 3 is a plot of poisoning due to Xe<sup>135</sup> versus rod position for each of the three rods. The poisoning,  $P$ , is defined to be the ratio of neutrons absorbed in the xenon to those absorbed in the fuel\* and is proportional to, but not necessarily equal to, the reactivity. For example, from Figure 3 it can be seen that when the poisoning is 0.06 it is

\*See Glasstone and Edlund, Page 334

necessary to position the No. 2 or No. 3 rod at about 22.3" to balance out the remaining excess, but the No. 1 rod must be inserted to 13.8" in order to accomplish the same result. Thus in the central region the No. 2 and No. 3 rods are 2.1 times as effective as the No. 1 rod.

3. In order to determine the absolute value of the reactivity per inch of rod, a measurement of the position of No. 2 rod at constant power and at two temperatures was made. At 120°F the reactor was critical with the No. 2 rod at 25.744" and at 86°F this rod was withdrawn to 24.764". The temperature coefficient is  $6.5 \times 10^{-3} \Delta k/k$  per °F. Thus the reactivity gradient for No. 2 rod is  $0.22 \Delta k/k$  per inch. A similar measurement for No. 3 rod gave 23.00" at 85°F and 23.625" at 119.3°F, resulting in  $0.34 \Delta k/k$  per inch. This difference is borne out by comparison of one rod against the other which shows No. 3 rod worth 1.32 times No. 2 as compared to a factor of 1.54 for the temperature coefficient measurements.

Because of the inconsistency of these results it appears that a more elaborate set of measurements are required. It seems clear, however, that the worth of the present rods is somewhat less than that obtained previously; i.e.,  $0.4\% \Delta k/k$  per inch for No. 2 rod measured in 1952.

Using the values obtained from the temperature coefficient measurements and taking No. 1 rod to be worth 0.46 as much as No. 2 rod and assuming the constant accelerations obtained in part 1, the rate at which reactivity will be removed upon initiation of a scram is given in Figure 4.

*JAC*  
J. A. Cox

JAC:gc

cc: A. F. Rupp  
A. M. Weinberg

Table 1

LITR 12/3/58

Rod No.	Magnet Release Time	Shim Rod Flight Time Data							Travel--in.*
		2"	6"	13"	21"	29.7"	29.3"	28.5"	
1	97	298	393	433	523	463			Time--msec
2	36	284	324	384	464		544		
3	42	338	408	473	548			613	

Above flight time data corrected for magnet release time.

\*Between release point and seat.

Figure 1a

# LITR LATTICE CONFIGURATION CHANGE NOTICE

CHANGE DATE \_\_\_\_\_

January 1, 1953

BEFORE CHANGE

	5	4	3	2	1		5	4	3	2	1
1	B	B	FX	I	B		B	B	FX	I	B
2	FX	I	F	S	F		FX	I	F	S	F
3	I	A	F	F	F		I	A	F	F	F
4	B	A	F	S	F		B	A	F	S	F
5	F	F	F	F	F		F	F	F	F	F
6	F	B	F	S	F		F	B	F	S	F
7	B	B	F	F	F		B	B	F	F	F
8	F	A	FX	FX	F		F	A	FX	FX	F
9	B	I	I	I	F		B	I	I	I	F

December 1, 1958

AFTER CHANGE

	5	4	3	2	1		5	4	3	2	1
1	B	B	FX	B	B		B	B	FX	B	B
2	FX	I	F	S	F		FX	I	F	S	F
3	I	A	F	F	F		I	A	F	F	F
4	B	A	F	S	F		B	A	F	S	F
5	F	F	F	F	F		F	F	F	F	F
6	F	B	F	S	F		F	B	F	S	F
7	B	B	F	F	F		B	B	F	F	F
8	F	A	FX	FX	F		F	A	FX	FX	F
9	B	I	I	I	F		B	I	I	I	F

## LEGEND

F - FUEL


B - BERYLLIUM

A - ALUMINUM

FX - PARTIAL FUEL

I - ISOTOPE STRINGER

S - SHIM ROD

 VERTICAL ACCESS FACILITY

 SPECIAL LATTICE PIECE

COMMENT: Changes are indicated in positions C-43, C-55, C-54, C-21, C-47, C-48, C-49, C-39,

C-28, and C-47

THIS PAGE AND HALF ELEMENTS.



FIG 3  
TIME OF FLIGHT  
 $\sqrt{3}$   
DISTANCE FALLEN

--●-- #1 Rod  
--○-- #2 Rod  
--△-- #3 Rod  
— THEORETICAL  
FREE FALL IN WATER

FEET

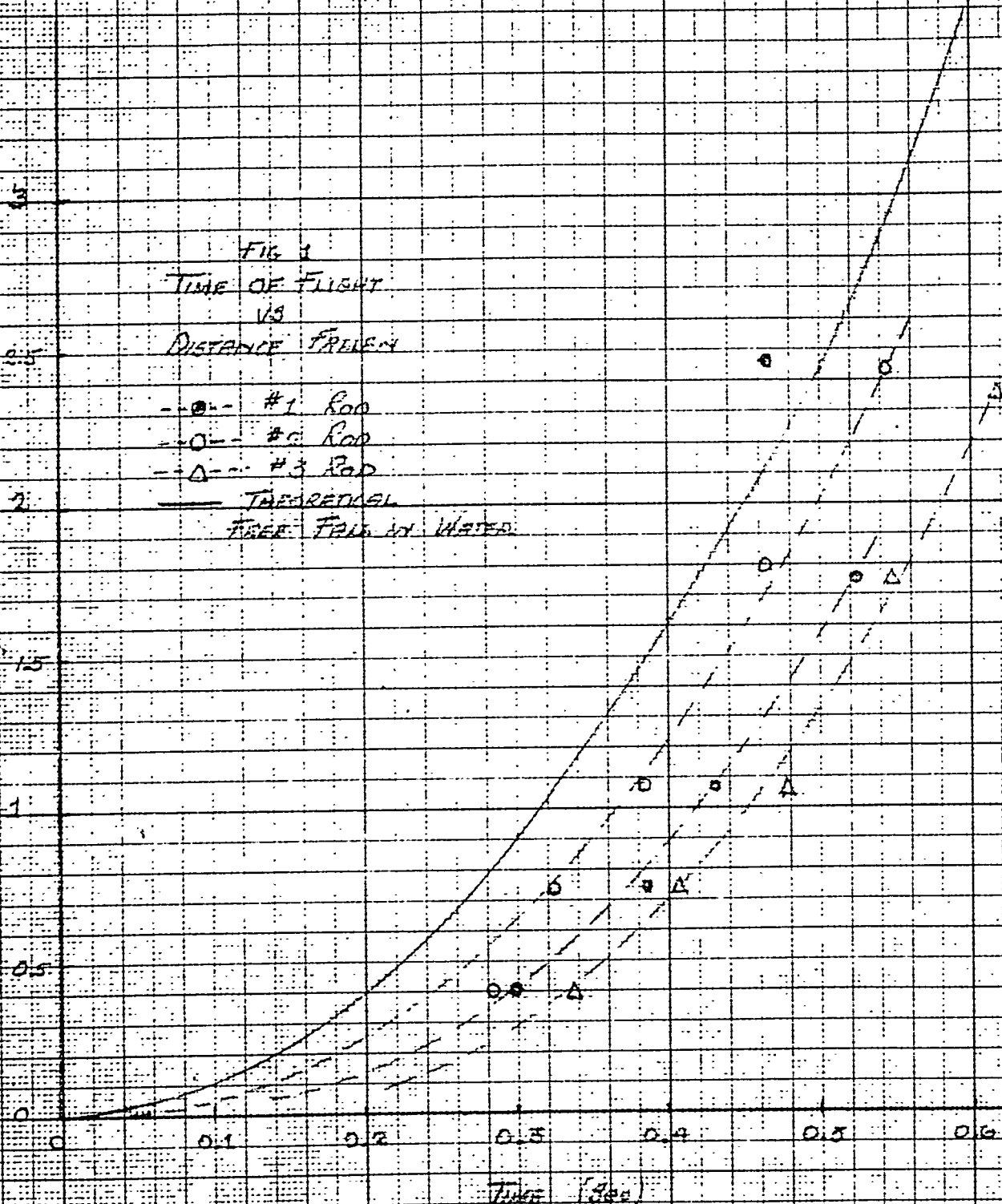


FIG. 2  
SQUARE OF FLEET TIME  
VS  
DISTANCE FALLIN

FROM THESE CURVES  
THE AGGREGATIONS ARE

#1 15.4 ft/sec<sup>2</sup>

#2 20.2 ft/sec<sup>2</sup>

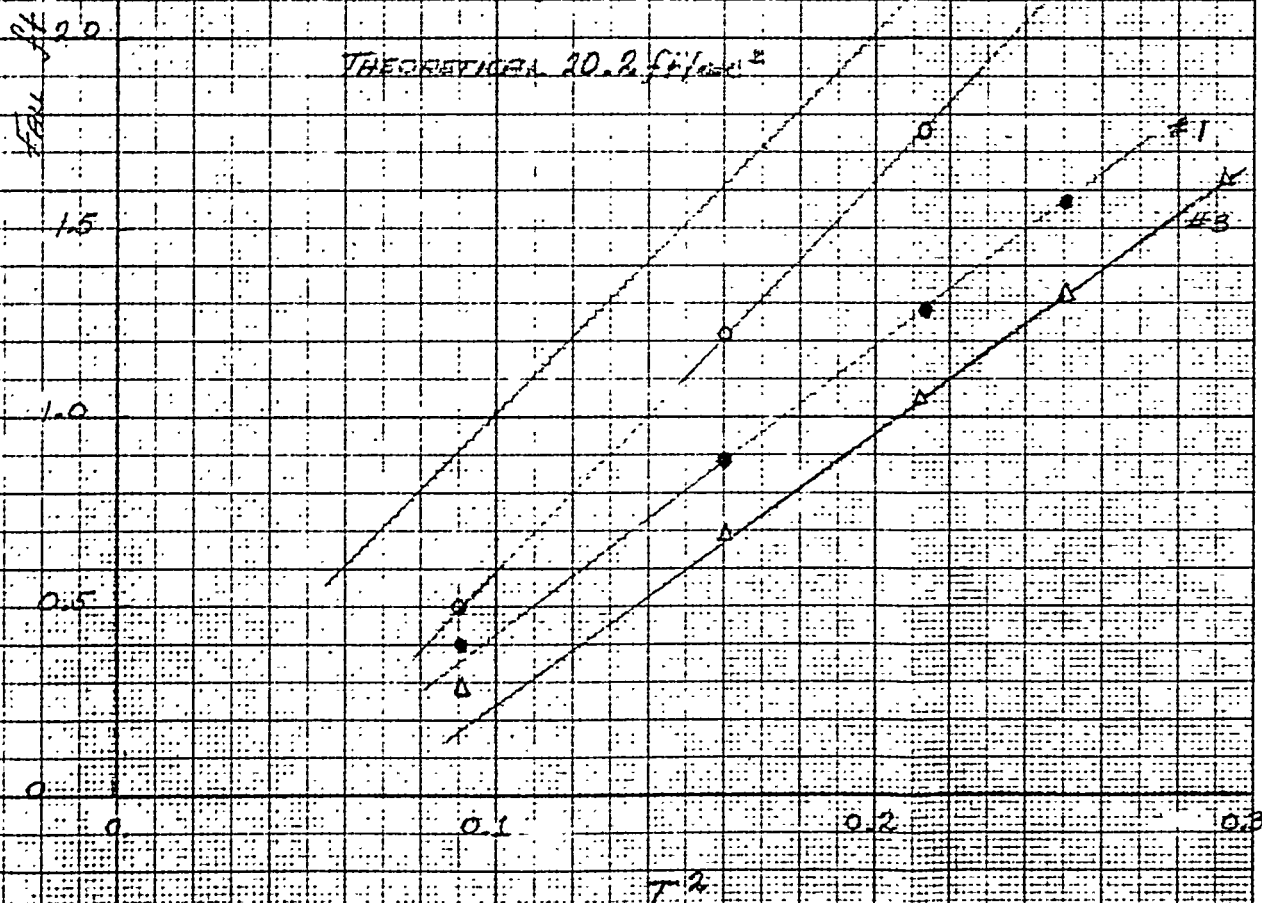
#3 15.4 ft/sec<sup>2</sup>

THEORETICAL 20.2 ft/sec<sup>2</sup>

THEORETICAL

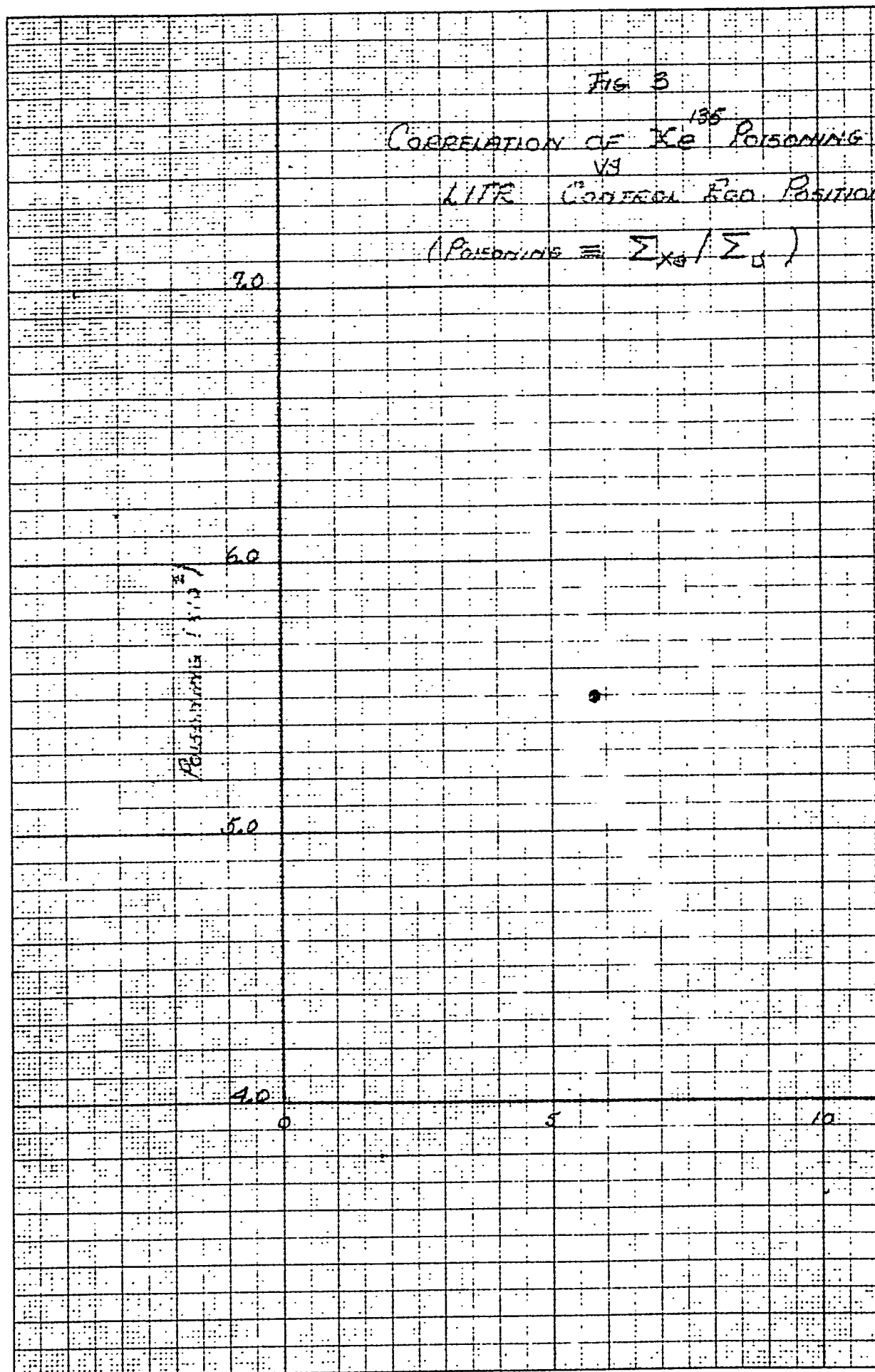
ft  
fall

T<sup>2</sup>



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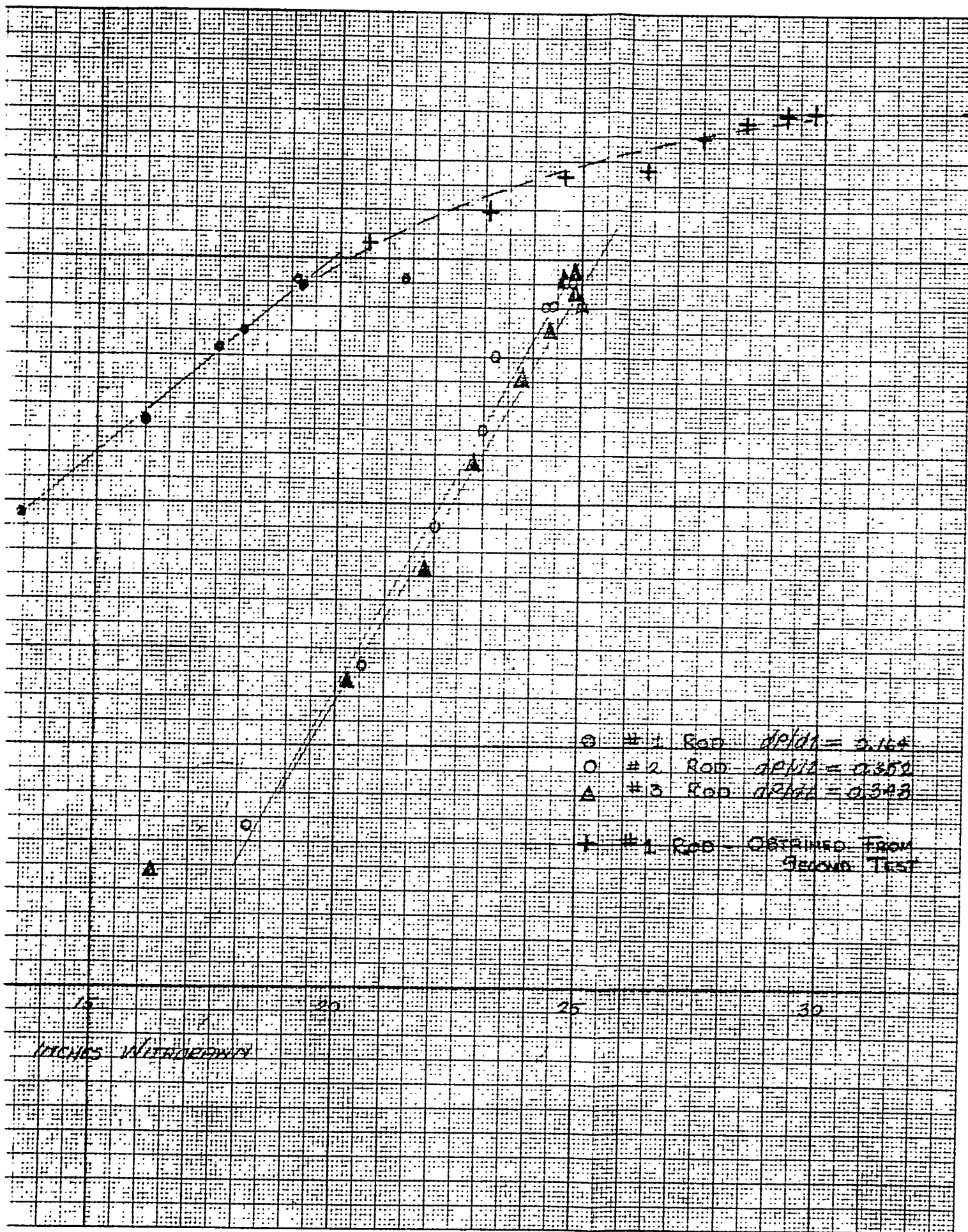
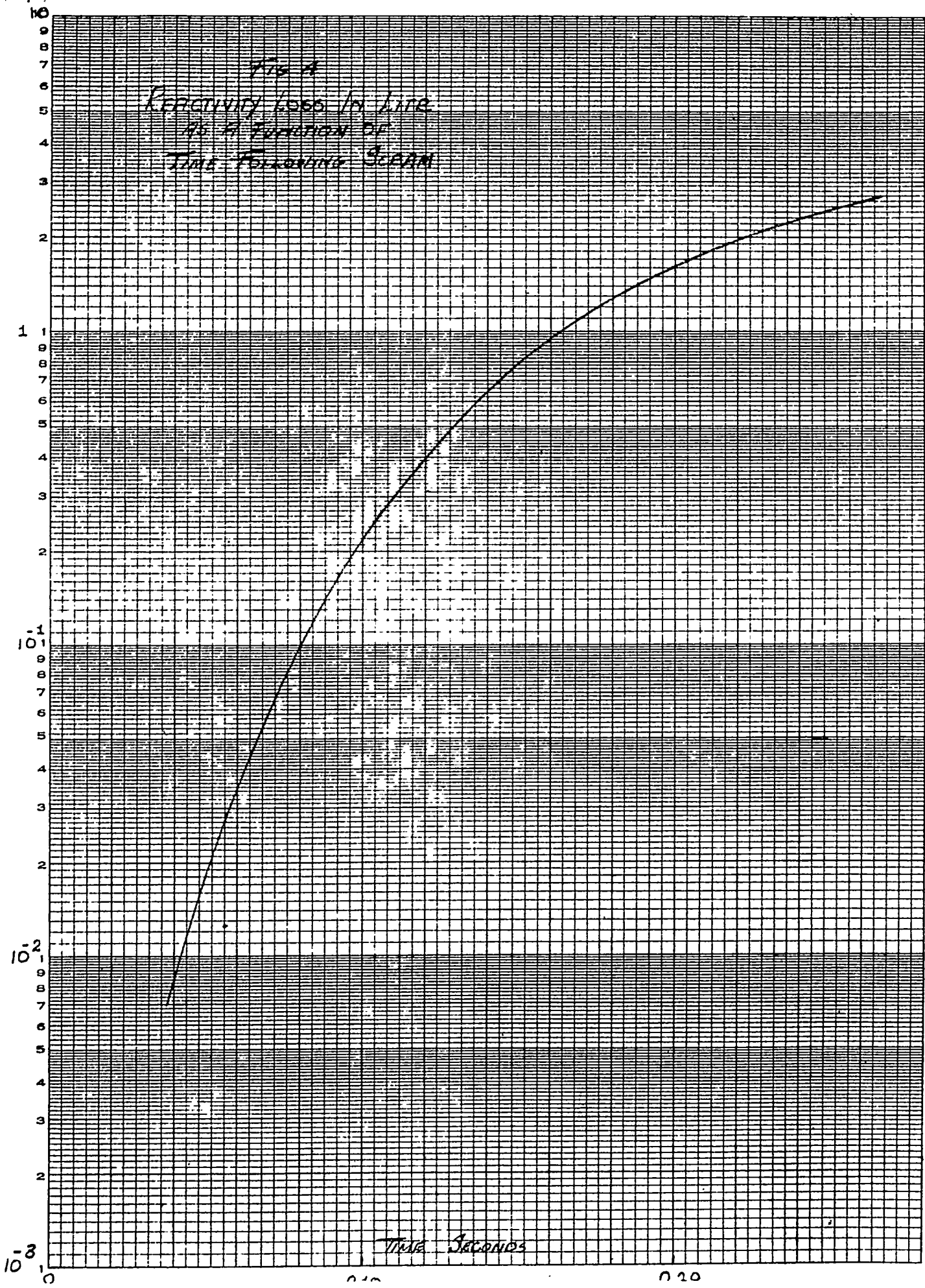


FIG. 1  
 REACTIVITY LOSS IN LINE  
 AS A FUNCTION OF  
 TIME FOLLOWING SCRAM



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## INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

November 11, 1959

To: M. E. Ramsey R. H. Ritchie  
 C. J. Borkowski C. E. Winters  
 E. P. Epler E. O. Wollan  
 F. W. Manning F. Kertesz

This document has been approved for release  
 to the public by:

Subject: Information for Review of LIIR Operation

*Daniel R. Hammin*  
 Technical Information Officer  
 ORNL Site

4/16/95  
 Doc.

Operation of the LIIR becomes more routine each year and requires less labor. There were fewer unscheduled shutdowns and a greater percent of operating time than last year.

Unscheduled Shutdowns

For the first three quarters of this year, eight shutdowns were caused by failure of reactor components compared to 17 during a similar period last year. Also there were 23 shutdowns from research equipment failure compared to 75 last year. This improvement is due to the program of standardizing equipment design, using reliable components, and increasing reliability in general.

## ANALYSIS OF UNSCHEDULED SHUTDOWNS

<u>Classification</u>	<u>Number</u>	<u>Downtime (hr)</u>
Human Error*		
Operations	3	8.883
Research	<u>6</u>	<u>2.083</u>
Subtotal	9	10.966
Equipment Failure		
Operations	8	11.450
Research	<u>23</u>	<u>56.550</u>
Subtotal	31	68.000
TOTAL	40	78.966

\*A few typical human errors that have resulted in reactor shutdowns are:  
 (1) accidental operation of a scram button on the control desk; (2) Misoperation in changing magnet amplifiers; and (3) accidental operation of safety switches in recorders or instruments while taking readings, adjusting charts, etc.

### Experiment Connection to Safety Circuits

The LITR is now using the dual-channel safety system in which the experiment is connected to the reactor safety circuits through "E" panels. A total of eight new experiments either have the new safety system or will have it before the experiments go into operation. Experiments in HB-2, HB-5, V-2, and C-48 still use the old method of tie-in to reactor safety circuits. The change to the new system has not progressed because of the serious shortage of instrument engineers available for this specialized type of work.

### Elementary Diagram

The LITR elementary control wiring diagram and the associated wiring drawings have been brought up to date and agree with the installation except for a few recent changes which are being added to the drawings.

### By-Pass Filter

A by-pass filter has been used on the LITR reactor water system with good success for about eight years. It has a capacity of several hundred gal/min and used cotton cord filter units. These disintegrated after six weeks service and had to be replaced frequently. The contaminated filters were very radioactive and were a considerable source of personnel exposure.

Sintered stainless steel filter units which can be backwashed in place are now being used, and these should eliminate most of the radiation exposure from the filters.

### Radiation Incidents

There were two incidents during 1959 involving the release of sufficient radioactivity from experiment facilities to require decontamination of personnel and of the immediate area.

The first occurred on April 28, 1959. A fuel capsule jammed in its vertical reactor facility tube and could not be removed normally. It was decided to pull the tube up, saw it off as far down as radiation limits would permit, and remove the bottom portion containing the sample to the hot cell. Another experiment tube was mistakenly cut off; and, upon flooding, water was sprayed over the adjacent working area. The tube had been in the reactor over a year during which time ruptures of fuel samples had contaminated the inside. The water turbulence in the tube after it was cut and flooded was not satisfactorily explained.

The second incident occurred on July 29, 1959, when a sample of elemental iodine ruptured in the pneumatic tube. As it was removed from the reactor to the magazine, air contamination was noted. A plug on the magazine designed to reduce gas leakage was not properly used, and this contributed to the amount of gas released. The elemental iodine had been in the polyethylene capsule for several months. Apparently, the iodine reacted slowly with the polyethylene, causing it to lose strength. Gas inside the capsule expanded while in the



reactor and ruptured the capsule. A sample inspection procedure has been instituted to attempt to forestall future occurrences of this type.

The three people present, as well as the immediate area, were contaminated. The clothing of one man read 10 mr/hr. It was necessary that the Medical Department decontaminate the nostrils of another man. However, no other internal exposures could be detected.

#### LTR FACILITY EMPLOYMENT

<u>Facility</u>	<u>Nature of Experiment</u>	<u>Division</u>
C-28, C-42, C-44	Fuel test	Reactor Projects
C-46, C-47, C-57, C-58		Operations
C-48, V-2	Fuel test	Reactor Projects (GE)
HB-1	Triton production and study neutron beam	Chemistry
C-43	Thorium slurry	Chemical Technology
HB-2, HB-5, HB-6	HRP solutions	REED
C-38	Crystal damage	Solid State
1/4 C-39	Dry tube for samples	Analytical Chemistry
3/4 C-39	Isotopes	Isotopes
1/5 P-tube	Pneumatic samples	Physics
3/4 P-tube	Isotopes	Isotopes
C-21, C-29, C-31, C-45, C-53, Regulating rod facility	Isotopes	Isotopes
HB-3		Operations
HB-4		Operations

#### Items Dropped Into Tank

Three items were dropped into the reactor tank since the last report-- a one-inch rubber stopper, an aluminum positioning pin, and a 5/32-inch nut from a magnet housing. The stopper was knocked out of the top of an experiment tube during operation, and the other items were found to be missing and presumed to be in the tank.

#### Control Rod Release and Drop Times

The procedure of checking the release time of the magnets and the time required for the rods to fall is now done routinely. One magnet was found to have a rather long release time and was replaced on 10-13-59 as shown in



the following table.

# CONTROL ROD TIME CHECKS

Date	Rod No. 1		Rod No. 2		Rod No. 3	
	Release	Drop	Release	Drop	Release	Drop
	(Time in msec)					
11-3-59	17.5	880	23	740	51	520
10-30-59 New magnet on No. 1 drive shaft	17	550	29.5	670	35.5	750
10-13-59 New magnet on No. 1 drive shaft	17.5	520	25	680	33	720
10-6-59	100+	740	24	860	41	760
9-29-59	100+	690	19	920	33	740
9-1-59	100+	620	24	680	34	660

## Worth of Shim-Safety Rods

The worths of the LITR shim-safety rods were determined originally by the distributed poison method using stainless steel strips as the poison. Since stainless steel displaces moderator, the poisoning effect is greater than that calculated from the neutron absorption cross section of the stainless steel. The worth of the rods as measured was, therefore, somewhat low. Only the lower half of the No. 2 rod was calibrated. By comparison with the shape of the calibration curves obtained at the ORR, the total worth of the No. 2 rod was 8.6%  $\Delta k/k$  as measured. The relative worths of the No. 1 and No. 3 rods were obtained by comparison with the No. 2 rod. At that time there was not a great deal of difference in the worths of the three rods due to the nearly symmetric loading of the fuel around the rods. The worths of the No. 2 and No. 3 rods were approximately equal with the No. 1 somewhat lower. The opinion, then, that the No. 2 rod was worth about 10%  $\Delta k/k$  was based upon the approximation that the calibration curve would be symmetric above and below the midpoint of travel (15 inches withdrawn). The ORR rods show the calibration curves to be symmetric about 16.5 inches withdrawn, however, and this should be true for the LITR due to the similarity of the rods. It was also known that the worth of the No. 2 rod, as measured with stainless steel, was somewhat low.

Since the startup of the LITR, the core loading has been shifted southward away from the No. 1 rod so that its worth was decreased to about 50% of that of the No. 2 rod.

During the latter part of 1959, an attempt has been made to increase the worth of the No. 1 rod by extending the core loading northward as much as


possible without detriment to the experiment program. Before this extension was started, an attempt was made to approximate the worth of the three rods by the period method and the standard inhour formula. If it can be assumed that the shapes of the calibration curves are the same as for the ORR and that the inhour formula will give a somewhat low value for the reactivity change due to a rod movement in a beryllium-reflected core, lower bounds of the worth of the three rods were:

No. 1	6.4% $\Delta k/k$
No. 2	11.0% $\Delta k/k$
No. 3	9.5% $\Delta k/k$ *

Since this measurement, a fuel element has been substituted for the beryllium reflector piece then in position C-11; and the weight of fuel per element in other positions surrounding the No. 1 shim rod has also been increased. Following these changes, a relative value check made by comparing the worth of the No. 1 rod to the No. 2 rod showed little gain in its worth. Further gains can be obtained only by relocating the half-fuel element experiment and radioisotope production facilities now in positions C-21 and C-31 and replacing them with full-weight elements. The worth of the No. 1 rod will remain lower than that of No. 2 and 3, however, because the core cannot be symmetrically loaded around the rods without destroying the usefulness of many of the experiment facilities.

In order to obtain some relation between the distributed poison and the period method of measuring reactivity at the ORR and LITR a series of measurements is being planned using the PTCF. These measurements will, it is hoped, provide some correlation between the use of borated plastic and stainless steel as distributed poisons in beryllium-reflected cores as well as to provide an applicable period equation.

\*Due to the lack of an accurate position measuring device on the No. 3 rod, there is some doubt as to the accuracy of this figure. A calibration against the No. 2 rod indicated that the worth of the No. 2 and No. 3 rods were almost equal.

  
J. A. Cox

JAC:gc

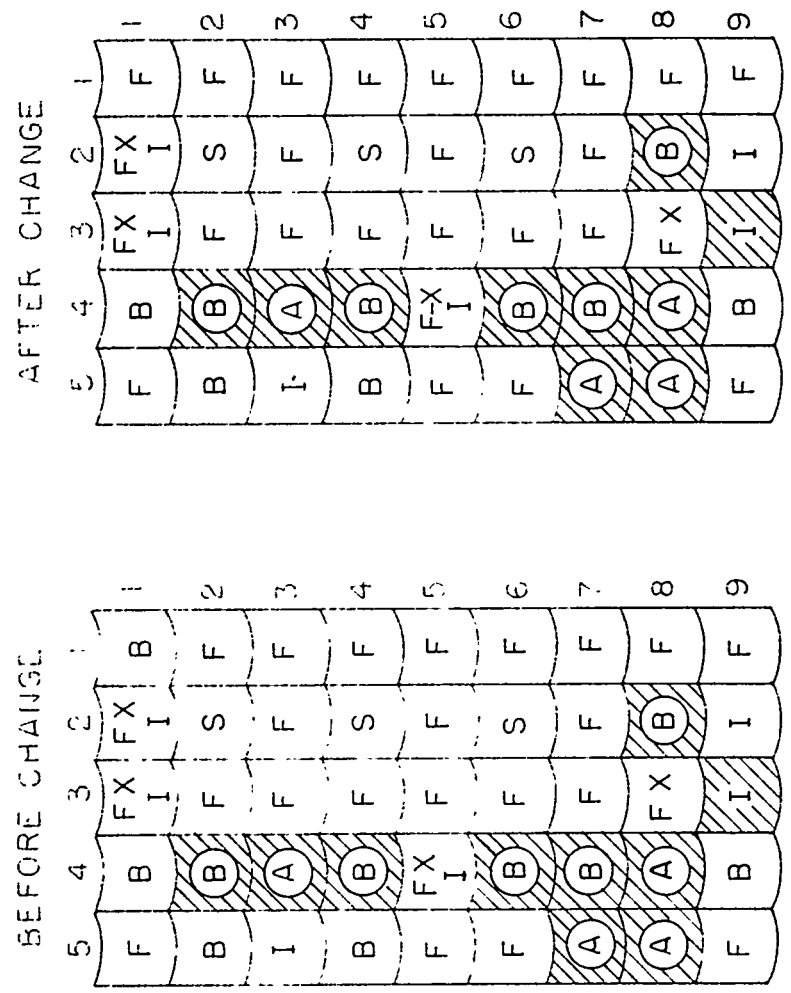
Attachment:LITR Lattice Configuration

cc: A. F. Rupp  
A. M. Weinberg

CLASSIFIED  
 UNCLASSIFIED DWG. NO. 1

LEGEND

- FUEL
- BERYLLIUM
- ALUMINUM
- PARTIAL FUEL
- ISOTOPE STRINGER
- SHIM ROD
- VERTICAL ACCESS FACILITY
- SPECIAL LATTICE PIECE



LITR LATTICE CONFIGURATION CHANGE

DATE OF CHANGE 9-22-59

## INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

November 4, 1960

This document has been approved for release  
to the public by

*David R. Hamm* 11/14/95  
 Technical Information Officer Date  
 ORNL Site

To: M. E. Ramsey R. H. Ritchie  
 D. C. Hamilton E. P. Epler  
 A. M. Perry E. O. Wollan  
 F. W. Manning F. Kertesz

Subject: Information for Review of LITR Operation

From: J. A. Cox, Prepared from reports by H. V. Klaus, W. R. Casto,  
 F. T. Binford, and K. W. West

The on-stream time of the LITR at the end of the third quarter of calendar 1960 was 88.8% compared with 87.8% last year and 82.2% for 1958. The slight improvement this year may be attributed to the lengthening of the cycle from three to four weeks starting last December. However, this improvement is not as much as expected due to more down time required for experiments.

The LITR now has more experiments than at any time in its history despite the fact that the beam holes HB-3, 4, and 6 are not being used. Table 1 shows the present usage of the LITR, and the core configuration is attached. There are now nine experimental tubes leading through the top plug, and one more (C-28) is being planned by the Solid State Division. Three experiments have leads coming out the side of the reactor vessel and, thus, present no encumbrances to top plug removal. There are only three Be pieces remaining in the core, giving the possibility of installing one more experiment with leads in C-28 and two without leads.

TABLE 1. LITR FACILITY EMPLOYMENT

Facility	Nature of Experiment	Division Sponsor
C-42, C-44, C-45	Air-cooled fuel test	Reactor Division
C-46, C-47, C-57, C-58 C-48, V-2, and C-52 (temporarily)	Air-cooled fuel test and radiation damage	Reactor Division (GE)
C-18, C-55	Radiation damage	Isotopes (NRL)
HB-1	Neutron beam	Chemistry
C-43	Thorium slurry	Chemical Technology
HB-2 and HB-5	HRP solutions	Reactor Division

LITR Facility Employment (Continued)

Facility	Nature of Experiment	Division Sponsor
C-38	Crystal damage	Solid State
1/4 C-39	Dry sample irradiation tube	Analytical Chemistry
3/4 C-39	Isotopes	Isotopes
1/5 P-tube	Pneumatic samples	Physics
3/4 P-tube	Isotopes	Isotopes
C-29, C-41, C-53, and regulating rod facility	Isotopes	Isotopes
HB-3, HB-4, and HB-6		Operations

Table 2 is an analysis of the 35 unscheduled shutdowns that occurred during the first three quarters of this calendar year. Experience this year compares favorably with 40 unscheduled shutdowns reported last year.

TABLE 2. ANALYSIS OF UNSCHEDULED SHUTDOWNS

Classification	Number	Down Time (hr)
Human Error		
Operations	1	3.983
Research	5	7.950
Equipment Failure		
Operations	14	30.684
Research	15	23.031
Total	35	65.648

The following gives a bit more detail on this table.

1. The one human error (Operations) shutdown occurred when a GCR Tube was placed in the wrong experiment facility and necessitated removing the top plug and changing it.
2. The five human errors (research) were:
  - a. Nozzle baffle on controller knocked loose.
  - b. A "disarmed" switch on the C-43 experiment.
  - c. Mistake in hose connections on GCR experiment.
  - d. Two sampling errors on C-48 experiment.
3. The 14 equipment failures charged to Operations were due to six power outages, five magnet breakdowns, and miscellaneous troubles in the safety system.
4. The 15 research equipment failures were due to:

- a. Four thermocouple failures.
- b. Four standardization switch troubles.
- c. Four controller failures (cables and tubes).
- d. Three miscellaneous items:
  - (1) Shutdown to eliminate a plug in C-43 experiment capillary.
  - (2) Shutdown for air activity due to a leak in C-48 experiment bellows connection.
  - (3) Shutdown for HB-2 experiment to check thermocouples.

Table 3 lists those shutdowns that were due to real causes.

TABLE 3. SHUTDOWNS DUE TO REAL CAUSES

Date	Duration (hr)	Cause
1-29-60	0.550	C-44 high temperature scram: The linkage on the nozzle-baffle arrangement in the pneumatic recorder-controller was accidentally knocked loose. This caused improper control valve operation, and the sample overheated.
3-21-60	2.633	C-44 high temperature scram: The cable drive on the controller broke causing improper control valve operation, and the sample overheated.
6-12-60	2.333	C-48 high temperature setback: A tube burned out in the controller causing improper control valve operation, and the sample overheated.
7-20-60	0.267	HB-2 low cooling-water supply pressure reduced the cooling flow to the setback point. No overheating resulted. The water system in this area is inadequate for certain loads.
7-27-60	0.233	C-44 high temperature scram at 1000 kw power on startup: Cooling air supply hose was improperly connected so check valve was not opened. (Clamps added to avoid this in the future.)
8-18-60	1.067	GE: Reactor manually shut down due to air activity.
8-25-60	2.550	GE: Reactor manually shut down due to air activity.

#### Radioactivity Releases

Three gaseous radioactivity releases occurred this year. All three occurred between August 18 and August 25, and two of the three (the first and third) were from the GE experiment in C-48. This involved the study

of fission product plate-out on a bellows section of the outlet, cooling-air line. The bellows were to be removed after a certain time and another sample bellows inserted while the reactor was operating. The glove box being used was not adequate for the job; and, following the first incident, another was made and installed which incorporated certain desirable changes. However, another incident occurred with the new box; and the restrictions then imposed resulted in cancelling the experiment, at least temporarily. Five of twelve smears taken in the sampling area counted  $>103$  d/m beta. One of these read 10 mr/hr, another counted  $8.7 \times 10^3$  d/m beta, and three ranged from 950 d/m to  $2.3 \times 10^3$  d/m beta. All five were taken above floor level at the sampling station. Smears taken on the floors at the midriff and on the top level all counted less than 500 d/m beta. The contaminated area was cleaned and resmeared, and all counts were less than 500 d/m beta. One man's left hand read 35 mr/hr, and another man's right hand read 1 mr/hr. Both were readily cleaned to background.

The other release at the LITR occurred on August 23 when a GCRE capsule was loaded into a carrier and sent to the ORR to go in the hot cell. Evacuation of the ORR was required shortly after the carrier was put inside. No trouble had been encountered during removal of the experiment at the LITR because an off-gas suction line was used to safely contain any air activity, and it is thought that this prevented the activity from being picked up by the CAM. The off-gas connection was removed while the carrier was being lowered to the south pad; and, accordingly, the LITR did not receive much of the release. After the sample was in the cask the CAM did alarm, but this was thought to be direct radiation from the higher background. The alarm cleared immediately as the cask was lowered to the ground level. The east room CAM indicated an increase in air activity shortly thereafter from 400 c/m, background, to  $\sim 6000$ . The west room activity rose from 200 to  $\sim 1000$ .

Procedures have been developed to prevent recurrences of the above nature. These include sealing the carriers in plastic and monitoring them for at least ten minutes before removing them to the south pad where they are connected to an off-gas connection and monitored for extended periods. This plastic sealing technique is only temporary until the carriers can be modified to incorporate more positive seals.

### Fuel Supply

In accordance with the policy of obtaining fuel from outside vendors, we received, in June, twelve fuel elements from the MTR. Due to the small number of elements used at the LITR, it is more economical to obtain elements from the MTR (these were manufactured by Babcock & Wilcox) than to place a separate order. The LITR and MTR elements are identical. Four of the twelve elements have been rejected due to poor brazing, and another order for twelve was recently placed. The introduction of more experiments in the core has required more fuel (17 to 18 pieces per year), and loss of the poorly brazed elements has reduced the stock to about four month's usage. If more elements are not received from the MTR soon, it may be necessary to manufacture several elements at ORNL.

### Jammed Fuel Element

Last June, during a routine fuel change, it was found that the element

in C-11 position was stuck by the locking cam on the lower grid. The MTR had experienced this same problem and supplied a tool for actuating the cam which is apparently jamming on the edge of the fuel element, lower end box. This tool, as well as several of our own design, has failed to do the job apparently because space is more restricted by the plate around the LITR Be reflector which does not exist in the MTR. (The LITR has an aluminum plate inside the Be to prevent the stacked blocks from sliding into the core area.) This plate prevents access to the cam. Currently, new removal tools are being designed.

### Filters

Sintered, stainless steel, filter cartridges, installed to reduce the radiation exposure experienced in changing the cloth or plastic cartridges, failed in September after about twelve months' service. The reason for this has not been determined, but nickel may have been used along with the stainless steel and this may have dissolved in cleaning with acid.

### Off-Gas Charcoal Traps

A work order for parallel charcoal traps to go in the building off-gas line has been issued. These traps will be sized to take care of 1% of the iodine in the fuel (on the assumption that 10% of the core melts down and 10% of the iodine is released). Prior to the graphite annealing, an LITR off-gas monitor, with the recorder in the Graphite Reactor control room, was installed.

### Experiment Safety Circuits

Three additional experiments (V-2, C-43, and HB-2) were converted during the past year to the double-track, ORR, "E" box, safety system. This leaves only the GE experiment in C-48 to be changed. The necessary work orders have already been issued for this.

### Magnet of New Design

A new prototype magnet, including a new armature and mechanical seat switch, was installed on October 21 in the No. 3 position. It operated properly on the initial rundown; the lower limit stopped the insertion at the right position and the rod was picked up normally. However, after scrambling the rod the magnet would not pick it up. After running the magnet down further by hand, the lower limit and the clutch lights came on. Inspection in the tank showed the drive badly bent. Fortunately, it was possible to straighten the drive in the dry dock. The armature appeared to be jammed with no play or centering motion, and the armature spring was replaced. After reassembly of the top plug, the lower limit was set as close as possible to the clutch since this magnet does not have as much compressibility as the old ones.

### Summary of Instrumentation Changes

Following is a summary of the major instrumentation revisions and additions made to the LITR during the past year.



#### Reactor controls and process instrumentation:

1. Existing controls were renovated to accept the new dual-instrument, double-track, experiment tie-in system. Three "E"-panel frames, family tie-in boxes, etc., were installed to provide proper experiment tie-in points.
2. All reactor control recorder, mercury switches were removed and replaced with cam-operated, micro switches.
3. The bridge circuit battery, standard cell, and standardizing mechanism in the No. 2 safety was replaced with a solid-state, constant-voltage supply on a trial basis for test and evaluation.
4. A particulate and fission-product radiation monitor was installed for the off-gas system. The readout and recording system has been located in the Graphite Reactor control room.
5. A flow monitor was installed in the off-gas system with the readout at the fan house.
6. A magnet of new design was installed on No. 3 shim rod.

#### Experiment controls:

1. The following experiments were renovated and updated to conform with the new, safety, tie-in system: HB-2, C-43, and V-2.
2. Instrumentation for the NRL experiment has been cleaned and new reactor access provided.
3. All annunciator units were changed to the Tele-alarm No. 416 NCL S2 type.

Preliminary investigation and design studies have been initiated for the following:

1. New, sealed-flux, monitoring chambers and elimination of the gas-flow system.
2. New sigma amplifiers, log N amplifier, and trouble monitor.
3. Addition of a third, level safety channel.
4. Updating of experiments C-52 and C-48.

#### Transportation of LITR Shim Rods

In order to make the transportation of spent LITR shim rods to the Graphite Reactor canal a safer operation, the carrier will be modified so that it will contain the shim rod even if dropped. The end of the shim rod is now held in a bucket attached with cables below the carrier in order to hold the fuel section inside the carrier. If the bucket were pushed

upward (by dropping the carrier) the fuel section would become exposed. This will be done by bolting a rugged extension piece on the carrier that can take the force of such a drop. The rod will also be pinned at the top of the carrier to guard against the shim falling out that direction in case the assembly were tipped over during transport.

#### New Cd-Al Shim Rod

It is contemplated that a new type LITR control rod will be designed and built in time to replace the rod presently scheduled for removal in the spring of 1961. The new control rod would be identical with the present rod except that the follower would consist of solid aluminum rather than of a fuel section and that the cadmium-poison section would be increased somewhat in thickness.

Chief among the advantages of such a redesign is the fact that once installed it would be necessary to change it only should it become damaged or at such time as the poison section is depleted. A careful investigation of the expected cadmium life has not yet been completed, but it is anticipated that the life should be several years.

The present rods are changed on a two-year cycle, and the removal of these rods is a rather hazardous procedure. Thus, the installation of essentially permanent rods would eliminate this hazard to a large extent. Moreover, the new type rod, even if removed, would not have associated with it the large quantity of fission products found in the fuel section of the present rods.

The aluminum-cadmium rods would be somewhat cheaper than the present rods on a unit basis; and, in addition, only three would be required.

While the use of these rods would reduce the control capacity slightly, it is not anticipated that it will be great enough to have a significant effect either on the safety of the reactor or on the full cycle. Calculations are under way to obtain an estimate of the effect, and these would be supported by experimental measurements with a single rod prior to commencing operation using this type rod. In addition, it will be necessary to assess the kinetic properties of the new rod since they will be of a different weight and cross-sectional area than the present ones.

Since the replacement of control rods in the ORR will represent well over one-third of the total fuel costs, it is attractive to consider a similar arrangement there. It is hoped that experience gained in the LITR would be of advantage in this respect.

  
J. A. Cox

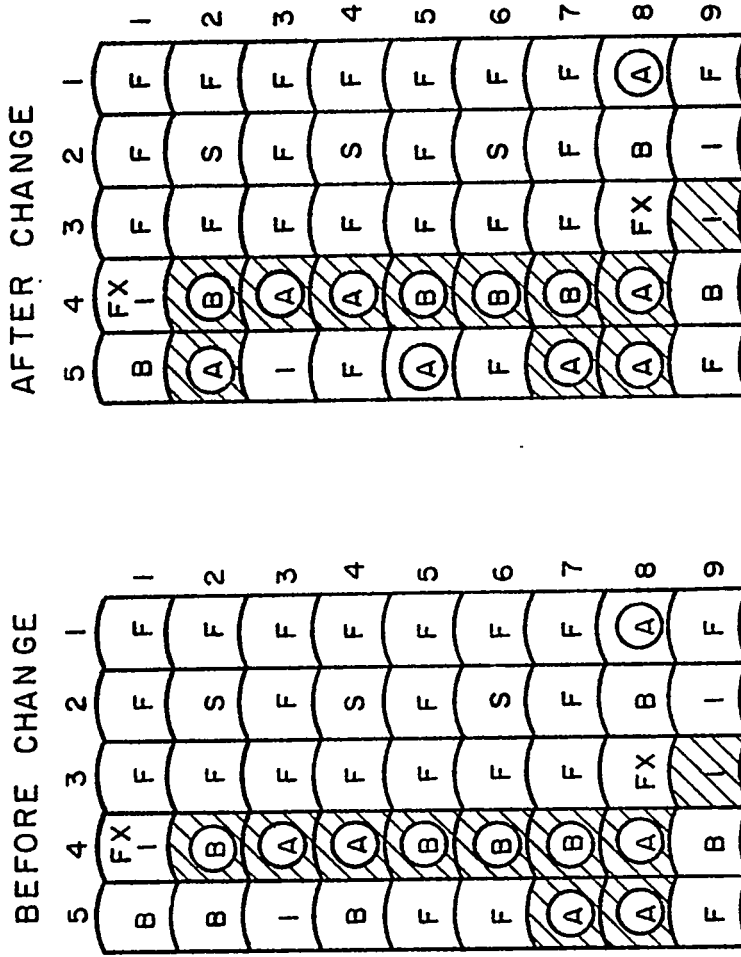
JAC:gc

Attachment: LITR Lattice Configuration

cc: F. R. Bruce; A. F. Rupp; A. M. Weinberg

# LEGEND

	FUEL
	BERYLLIUM
	ALUMINUM
	PARTIAL FUEL
	ISOTOPE STRINGER
	SHIM ROD
	VERTICAL ACCESS FACILITY
	SPECIAL LATTICE PIECE



1ST CHANGE 8/23/60 NRL IN C-55

2ND CHANGE 9/20/60 GE IN C-52

LITR LATTICE CONFIGURATION CHANGE

4-60

Overall Project in CTR Experiment

### Basis of calculation -

#### A. Power developed in sample

$$\frac{6}{235} M \times 10^{23} \times 560 \times 10^{-24} \times 200 \times 1.6 \times 10^{-16} \phi = P$$

$M = \text{grams U}^{235}$   $\phi = \text{flux}$   $P = \text{power in KW}$

$$P = 4.576 \phi M \times 10^{-14}$$

#### B. Production of Iodines

(Based on Ruyford & Burnett)

Nuclide	Activity/kw	$T_{1/2}$	168 hr. Occ. Iod. in air (Ruyford)
$I^{131}$	25.4 curies	8d	$3 \times 10^{-9}$ pc/cc
$I^{132}$	40.0	2.3h	$8 \times 10^{-8}$
$I^{133}$	59.0	21h	$1 \times 10^{-8}$
$I^{134}$	69.0	52m	$2 \times 10^{-7}$
$I^{135}$	53.6	6.7h	$4 \times 10^{-8}$

- Curies present -

Facility	$U^{235}$	flux	$I^{131}$	$I^{132}$	$I^{133}$	$I^{134}$	$I^{135}$	Total FP
GCR	2.35g	$10^{18}$	95	150	221	258	201	
HB1	1.25g	$7 \times 10^{12}$	32	50	74	86	67	
C-4B	1.25g	$2 \times 10^{13}$	29	46	68	79	61	
TOTAL			156	246	363	423	329	20,000

\* 7 samples 1.25 g each

In addition to this there are two experiments containing Thorium. One which contains 1.12 grams of Thorium oxide at a flux of  $2 \times 10^{15}$  is estimated by the experimenter to contain 1 curie of  $I^{131}$ . The other contains the equivalent of 200 gms of Thorium oxide at a flux of  $2 \times 10^{12}$  and thus would contain 34 curies of  $I^{131}$ .